

# 13TH VIRTUAL UNISEC-GLOBAL MEETING

## 18 SEPTEMBER 2021

Kamel BESBES, Prof.  
Director General of Centre for Research on  
Microelectronics and nanotechnology, Tunisia



# Higher Instance of Coordination

**MHESR:** Ministry of Higher Education & Scientific Research  
(President)

**MDN :** Ministry of Defense (Secretary)

**MA:** Ministry of Agriculture

**MT:** Ministry of Transport

Gov.  
Ministries

**CNEEA**

National Commission  
for Outer Space Affairs.

Agencies  
& Offices

Universities  
Research  
Centres

**CERT:** Research and Studies Communication Centre

**CRMN:** Centre for Research on Microelectronics and Nanotechnology

Universities, Labs and Scientific Associations



**CNCT :** National Mapping & Remote Sensing Centre

**ANF :** National Agency of Frequencies

**INM :** National Institut of Meteorolgy



## INTERNATIONAL SPACE OFFICES & ONG INSTALLED IN TUNISIA



OBSERVATOIRE DU SAHARA ET DU SAHEL  
SAHARA AND SAHEL OBSERVATORY

**CRTEAN:** North African Center for Remote Sensing

(Mauritania, Morocco, Algeria, Tunisia, Libya, Egypt, Sudan)  
Regional collaboration (north Africa)



**AICTO:** Arab ICT Organisation

(All arab countries: Arab League)  
BEIDOU training Centre



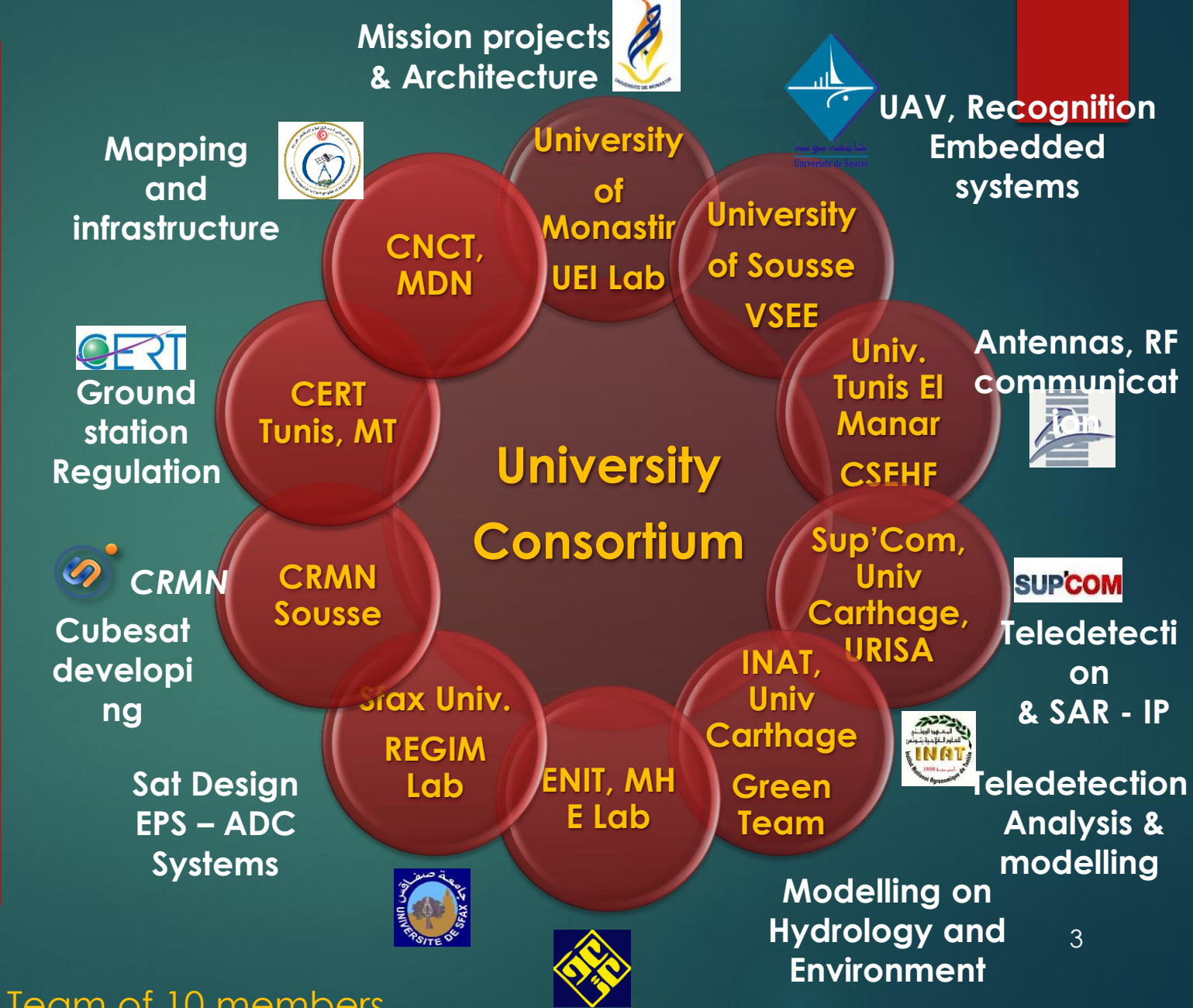
African Association for Geospatial Development





Since 2013, Objectives:

- Promotion of National and International projects and cooperation
- Promotion of the alliance
- Organization of events
- Communication and dissemination
- Promoting academic training



Team of 10 members



# UNISEC Activity



- ▶ How to develop a large network for space in Tunisia ?
- ▶ How to influence public policies on space technologies interest ?
- ▶ How disseminate and inform public about space events and training programs ?
- ▶ How to increase and Developing international collaboration ?

## Strategy to be deployed to develop space activities in Tunisia

- ▶ Advance in the implementation of **actions within the agenda of the National Strategy**
- ▶ Develop an **alliance** to activate the strategy
- ▶ **Enlarge to the different sectors** of interest
- ▶ Propose a **short-term projects** to finance, consolidate and prepare for next steps
- ▶ Give **national and international visibility**
- ▶ Building a **multi-stakeholder** strategy
- ▶ Consolidate **international collaborations**
  - ▶ UNISEC Global, Japan, Turkey, Germany, Egypt,..
  - ▶ UNOOSA - EU – China - India, Russia, ...

## Tunisian Space Strategy

A Tunisian ambitious program of space accessibility was launched in **March 2018** by the Ministry of Higher Education and Scientific Research with strategic departments such as the Ministries of Defense, Agriculture, Environment and the Digital Economy.



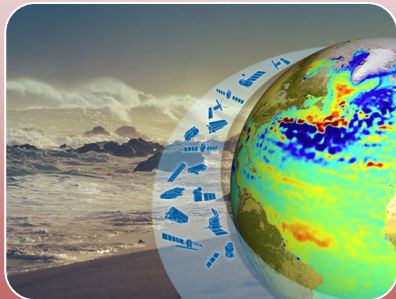
### **Overall objective: The space sector is a driver of sustainable development**



#### **Specific Objective 1: Organise and enhance the space sector**

##### **A1: Develop and Adopt the National Space Sector Strategy**

- (Shared vision )
- A2: Create a horizontal structure responsible for the organization of the space sector
- ( Governance and Organization)
- 



#### **Specific Objective 2: Use of Space Applications and Technologies**

- A3: Developing knowledge and know-how in the space field
- (Education, Skills)
- A4: Systematically dispose of and use of space infrastructure and technologies
- (Economy and society)

**To be deployed in 15 Actions with expected results**

# The EU-Tunisia Association to H2020 Research and Innovation program Pillar : Industrial leadership, SPACE

2016-2020 : SPACE NCP and CP

12 infodays (TN)

- 2016: CRMN (1)
- 2017: CRMN (1) + CNCT (1)
- 2018 : Hammamet, Sfax Hotel Zitouna (Telnet), Université de Sfax, AM Borj El Amri, CRMN
- 2019: ISET Sousse (1), CRMN (2), CNCT (1)
- 2019 Intervention Radio Med

6 Infodays & Brokerages (EU)

- 2016-2018 : Invités et pris en charge pour les événements COSMOS
- Prague, Lisbonne, Bruxelles, Rome, Crète, WebCast
- A partir de 2019 la Tunisie est Membre du Réseau NCP: Cosmos Plus 2020 (8000 Euros)



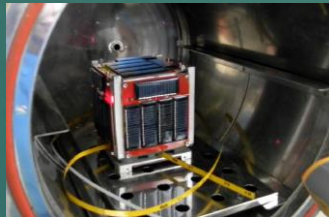


# Fabrication & Applications of Cubesats in Tunisia

Clean room ISO 6 for nanosat assembly



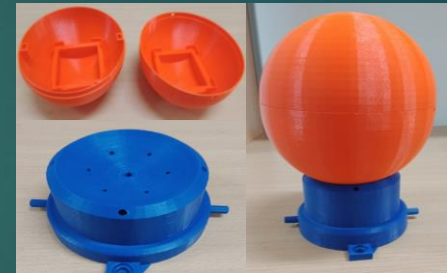
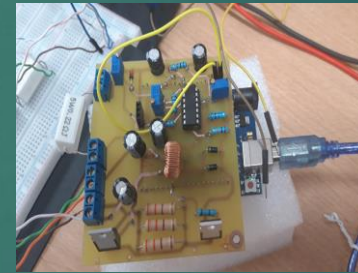
Vacuum and T° test  
ISO 19683:2017



Electronic Modules for CubeSat

## 5 Expected results of the FACT project:

- R1:** Realization of a CubeSats assembly platform
- R2:** Realization of a CubeSats test platform
- R3:** Realization of a functional prototype of CubeSat
- R4:** Development of skills in the space tech field
- R5:** Communication, dissemination and sustainability



- Study and realization of a Battery Simulator for CubeSat Study
- Development of a Solar Array Simulator for CubeSat
- Design of SDR-LORA beacon for water quality control
- Design of a test bench for ADCS system of a x1U CubeSat
- Development of Ground station based on SDR module

### Projects

- WQM, Payloads (Istanbul TU)
- Tricom-1R (Tokyo University)
- Orbital constellation (Wurzburg Univ)

Training with : UNOOSA, Graz Univ, Samara Univ. ISRO, CAST, ASI, ...



## Tunisia Chapter

Creation on December 2019

- Chair: Riadh Abdelfattah (SUP'COM),
- Vice-Chair: Kamel Besbes (CRMN),
- Secretary: Yassine Ben Salem (ENIG),
- Treasurer: Zouhaier Ben Rabah (CNCT),
- Chapter Advisor/Counselor (for Student Branches): Samer Lahouar (CRMN),
- Industry relations coordinator: Ferdaous Chaabane (SUP'COM),
- Communication, IT and website management: Leila NASRAOUI (ENSI)



March 9–11, 2020, Tunis, Tunisia

Organizers



Invitation to M2GARSS 2020 in Tunis

Hosted by the IEEE Geoscience and Remote Sensing Society (IEEE GRSS), the Mediterranean and Middle-East Geoscience and Remote



## IEEE GRSS 2020 Chapter Excellence Award to Tunisia Section Chapter

### Acquiring an Educational nanosat (ESAT) kit (Dec 2021)

- Acquiring 1 educational nano-satellite for hands-on training,
- Different configuration options for classrooms: Creating synergy between MENA chapters
- The potential users: GRSS members and student chapters through class programs and student grand-challenges.
- The nanosat kit remains the property of the local chapter







# SANM

SPACE ALLIANCE FOR EMERGING APPLICATIONS

**National consortium to contribute to deploy actions in acceleration of space national strategy**

▶ **New consortium built with stakeholders 2019**

▶ **Universities**

- ▶ UEILab FSM/CRMN
- ▶ INAT
- ▶ SUPCOM
- ▶ ENIS

**Ministries & Agencies**

- ▶ CNCT
- ▶ ANF
- ▶ DGCI
- ▶ City of Sciences

**Associations**

- ▶ ONG: UNISEC, Ageos, GRSS

# Events and conferences



The 7th **Mission Idea Contest**  
For Deep Space Science and Exploration

**Journée de l'ESPACE**  
Samedi 10 Octobre 2020  
à partir de 10h30 à la Cité des Sciences à Tunis

**GALILEO MASTERS**  
www.galileo-masters.eu  
EXTENDED UNTIL 21 JULY

**Copernicus masters**

13 & 14 November 2020  
INTERNATIONAL SPACE HACKATHON  
#AIS 2020  
Tunis, Sousse, Sfax

RÉPUBLIQUE TUNISIENNE **MESRS**  
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique  
Centre for Research on Microelectronics & Nanotechnology  
Technopole Sousse  
SAMA

**Pour un Réseau National Thématique sur l'Espace**  
Webinar le Mardi 1 Décembre 2020 de 14h à 15h45

14H: Ouverture et présentation des intervenants  
Grands objectifs du RNT et de la stratégie spatiale en Tunisie (Pr Kamel Besbes)

14H10: Thème 1: EO, GNSS et SIG (20 mn)  
INAT/GREEN team: EO et applications pour le développement durable (Pr Zohra Lili Chabaane)  
CNCT: services de l'EO pour les institutions, les entreprises et les citoyens (Ing. Houraya Sahli Chahed)

14H30: Thème 2: Science et Technologie Spatiale (20 mn)  
Uei lab/CRMN: Maîtrise des technologies spatiales à travers les nanosatellites (Dr Samer Lahouar)  
GEOGLOBE/ENIS: la Tunisie et les projets de valorisation de l'exploration de la lune et de mars (Pr Chokri Yaich)  
ANF: Radio Communication Spatiale (UIT-MIF) (Ing. Gen. Meherzia Ouni)

15h00: Thème 3: gouvernance et valorisation du spatial (30 mn)  
DGCI-MESRS: le CNEEA et la gouvernance du domaine spatial en Tunisie (CSP Malek Kochlef)  
CST: valoriser et exposer les sciences et technologies spatiales (Mme Sarra Snoussi)  
AGEOS: l'espace, vecteur de développement économique (Dr Nesrine Chehata)

15h30: Discussions et réponses aux questions

**WORLD CANSAT / ROCKETRY CHAMPIONSHIP**

INDIA | SERBIA | ITALY | CANADA | TUNISIA | PERU

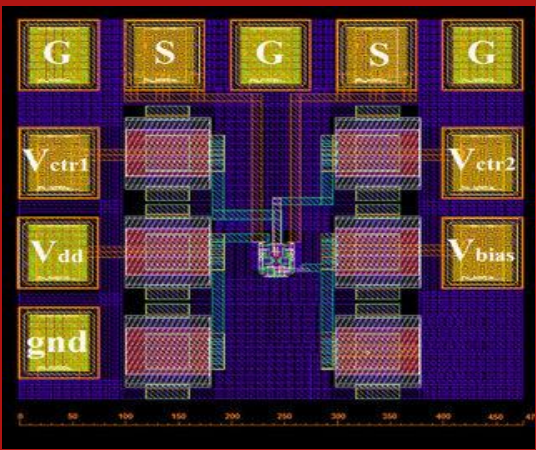
**WCRC**

WORLD CANSAT ROCKETRY CHAMPIONSHIP

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PHONE: +91 9740496061 | WEBSITE: WWW.WCRC.WORLD  
EMAIL QUERIES: WCRC.WORLD@GMAIL.COM

**IADE TUNISIA**  
INTERNATIONAL AEROSPACE & DEFENSE EXHIBITION  
4-8 MARCH 2020 DJERBA-ZARZIS





Journal of Circuits, Systems and Computers | Vol. 26, No. 04, 1750055 (2017)

### An Enhanced Design of Multi-Band RF Band Pass Filter Based on Tunable High-Q Active Inductor for Nano-Satellite Applications

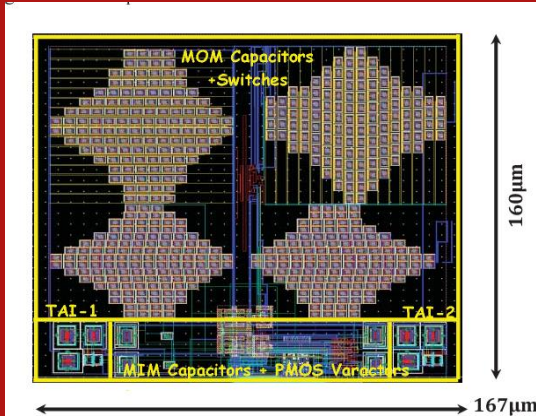
Aymen Ben Hammadi, Mongia Mhiri, Fayrouz Haddad, Sehmi Saad and Kamel Besbes

DOI: 10.1109/JCS.2016.7843051 • Corpus ID: 23242997

### An L, S and S2 bands, compliant LC-based DCO for amateur Nano-satellite applications

S. Saad, M. Mhiri, K. Besbes • Published 2016 • Materials Science, Computer Science • 2016 11th International Design & Test Symposium (IDT)

This paper presents a LC-based digitally controlled oscillator (DCO) with an enhanced frequency resolution and an extended linear frequency tuning range. It generates frequencies between 1.22 and 3.52 GHz that covers three main bands defined for amateur Nano-satellite applications (L, S and S2). The DCO exploits a new tunable active inductor (TAI) that achieves a high Q-factor with a maximum value of 98 over a frequency range of 1770 MHz. It uses from 3.55 nH to 15.2 nH. Furthermore, a tuning circuitry based on a capacitive degeneration network formed by a capacitance with an additional resistance, is employed to achieve a low frequency resolution without any dithering. The achieved frequency resolution is approximately between 3 and 16 kHz. The DCO exhibits a phase noise of  $-105.8$  dBc/Hz at 1MHz frequency offset and an FoM of  $-175$  dBc/Hz. Finally, the circuit consumes 5.2 mA current when it is designed in a 90-nm nine-metal CMOS technology with an operating supply voltage of 1.0 V.



2016 11th International Design & Test Symposium (IDT)

### An L, S and S2 bands, compliant LC-based DCO for Amateur Nano-Satellite Applications

Sehmi Saad<sup>1</sup>, Mongia Mhiri<sup>1</sup>, Aymen Ben Hammadi<sup>1</sup> and Kamel Besbes<sup>1,2</sup>

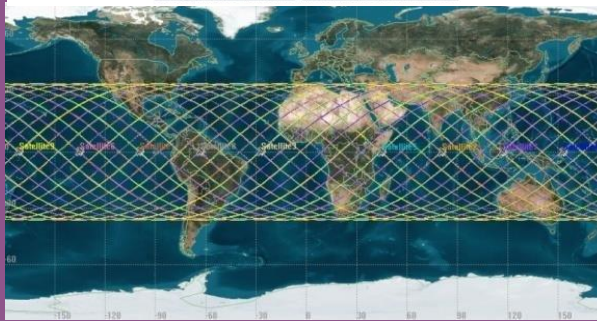
<sup>1</sup>Microelectronic and Instrumentation Laboratory, LR-13ESI2, University of Monastir, Tunisia  
<sup>2</sup>Center for Research in Microelectronics and Nanotechnology (CRMN), Technopark of Sousse, Tunisia  
 sehmi.saad@fsm.rnu.tn, mongia.mhiri@fsm.rnu.tn, aymen.benhammadi@fsm.rnu.tn, kamel.besbes@fsm.rnu.tn

## Constellation of Pico-Satellites for 3D Earth observation

NissenLAZREG<sup>1</sup>, Kamel BESBES<sup>1,2</sup>

<sup>1</sup>Microelectronics & Instrumentation Lab, Faculty of Sciences of Monastir; University of Monastir, Tunisia  
<sup>2</sup>Centre for Research in Microelectronic & Nanotechnology (CRMN), Technopark Sousse, Tunisia

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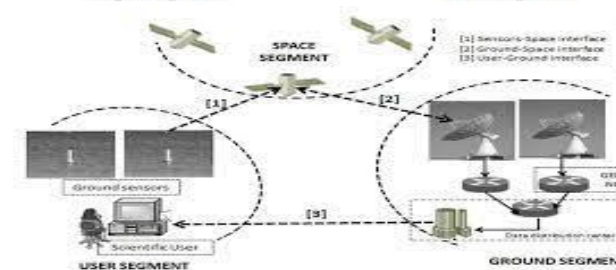
Advances in Space Research  
 Volume 61, Issue 4, 15 February 2018, Pages 1017-1024

### Analysis and design of Cubesat constellation for the Mediterranean south costal monitoring against illegal immigration

Nissen Lazreg<sup>1</sup>, Omar Ben Bahri<sup>2</sup>, Kamel Besbes<sup>1,2</sup>

## Small Satellite and Multi-Sensor Network for Real Time Control and Analysis of Lakes Surface Waters

Nader Gallaib<sup>1</sup>, Kamel Besbes<sup>2</sup>  
<sup>1</sup>Microelectronics & Instrumentation Lab, University of Monastir, Monastir, Tunisia  
<sup>2</sup>Microelectronics & Instrumentation Lab, University of Monastir, Monastir, Tunisia



(IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 8, No. 3, 2017

### Water Quality Monitoring based on Small Satellite Technology

N. Gallaib<sup>1</sup>, O. b. Bahri<sup>1</sup>, N. Lazreg<sup>1</sup>, A. Chaouch<sup>1</sup>  
<sup>1</sup>Microelectronic and Instrumentation Lab  
<sup>2</sup>Faculty of sciences, University of Monastir  
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Kamel Besbes<sup>1,2</sup>  
<sup>2</sup>Center for Research on Microelectronics and Nanotechnology, CRMN  
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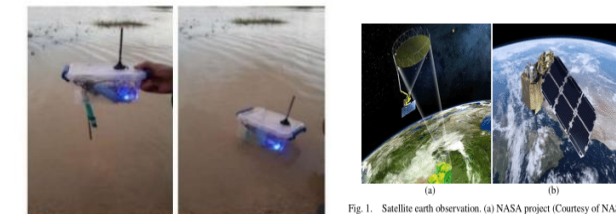


Fig. 1. Satellite earth observation. (a) NASA project (Courtesy of NASA), (b) ESA project (image by ESA/ATG medialab)

Prototype of the system with microcontroller board, sensors and SDR module

However, the satellite earth observation systems present always gaps. The earth observation methods used for water quality monitoring are based on sensors resolution. Indeed,



### Didactic satellite based on Android platform for space operation demonstration and development

Omar Ben Bahri<sup>1</sup>, Kamel Besbes<sup>1,2</sup>



### Smartphone-Based Telemedicine Supported by Pico-Satellite Constellation

Omar Ben Bahri, Nissen Lazreg & Kamel Besbes

Pages 726-735 | Published online: 20 Mar 2018

Download citation | <https://doi.org/10.1080/03772063.2018.1488212> | Check for updates

Full Article | Figures & data | References | Citations | Metrics | Reprints & Permissions | Get access

#### ABSTRACT

Many people in developing countries are required to travel for several hours to see a doctor. The concept of so called telemedicine accompanied with developments in the field of wireless communications may improve the health care. Here presented telemedicine system is for a distance consultation. It is based on a pocket smartphone using its camera to develop a video broadcasting mission for a real-time consultation. However, developing countries in the Middle East and North Africa suffer network coverage in most areas. To overcome this issue, the system includes a software defined radio in order to integrate the small satellite technology in the telemedicine routine. The proposed pico-satellite constellation can provide an interesting solution for near real-time transmission, which will significantly improve the health care in remote areas.

KEYWORDS: Constellation, MENA, Pico-satellite, SDR, Smart system, Telemedicine

### Registration and correction techniques in Cubesat remote sensing images

Nissen Lazreg<sup>1</sup>, Rochdi bouachba<sup>1</sup>, Kamel Besbes<sup>1,2</sup>

<sup>1</sup>Microelectronics & Instrumentation Lab, Faculty of Sciences of Monastir, University of Monastir, Tunisia  
<sup>2</sup>Centre for Research in Microelectronic & Nanotechnology (CRMN), Technopark Sousse, Tunisia

lazreg.nissen@yahoo.fr, rochdi.bouachba@gmail.com, kamel.besbes@fsm.rnu.tn

**Abstract**— Under the cover of the earth, the high-altitude orbits and geostationary orbits provide high temporal resolution but remain poor in terms of spatial resolution. Image registration is a fundamental task in image processing used to match two or more images which are taken at different time, from different sensors or different viewpoints. Also, this type of task can obviously meet the demand of the high spatial resolution at low altitude view but a high number of spacecraft. This paper investigates the positioning accuracy of image. We propose a new feature-based approach to detect changes between a pair of low images taken from different Cubesats or from one Cubesat but in different incidence angle in different time. This approach is based on the SIFT algorithm. It can deal with multi-resolutions, multi-sensors and multi-incidence angles situations, and it offers promising results.

Keywords— Cubesat; Image registration; Photogrammetry; SIFT.

Remote sensing using Cubesat which allows direct data downlink to various small ground stations, eliminates the need for a centralized processing and distribution system while yet providing the advantages of real-time access to the observations concerned, small size databases and easy information distribution within areas not well served by communications systems. Furthermore, this is very important for disaster prevention: earthquake forecasts, early detection of tropical storms and predictions of volcanic activity. Earth Observation missions usually require that the same area on earth is likely to be imaged every certain amount of time and this is achieved by implementing repeating ground track orbits. Several satellite-based imaging systems can quickly acquire images at different view angles. These include the Multispectral Thermal Imager (MTI) [3, 4], IKONOS [5],

### Autonomous and In-situ Water Quality Monitoring System for Real-World Applications

Nader Gallaib, Omar Ben Bahri, Zied Gafsi and Kamel Besbes  
 Microelectronics & Instrumentation Labs, University of Monastir, Monastir, Tunisia  
 Email: kamel.besbes@fsm.rnu.tn

**Abstract**— In order to improve the routine of water quality monitoring and reduce the risk of acute or deliberate contaminations, this paper presents, the development of low cost and durable online water quality systems includes multi-parameter sensors, acquisition card, communication system and another accessories. These sensors can be installed across water distribution networks within an interface to control the conditions flow and pressure of the large volume water samples (rivers, lakes). The flow water is made through a channel which is designed on one side of this interface. In our system, we propose to use the small satellite technology offered by the international spatial project such as Hubsat. Data collected by various sensors such as temperature, pH, and turbidity are sent via Bluetooth to the Hubsat-UBR Bridge which is equipped with a Bluetooth module, memory, microcontroller, modulator, transceiver and UHF antenna. The bridge is responsible for the satellite communication. A novel WSN architecture was proposed.

**Index Terms**— Flow channel interface, autonomous, on-line water monitoring, sensor networks.

**I. INTRODUCTION**  
 Surface water quality monitoring is one of the most important activities in environment monitoring domain. The number of scientific research and development systems in this area is extremely large.

The MENA region is projected to experience an increase of 3°C to 5°C in mean temperature and 20% decline in precipitation by the end of this century (IPCC, 2007). The consequence of this climate change on water run-off is es-

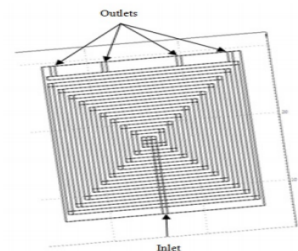
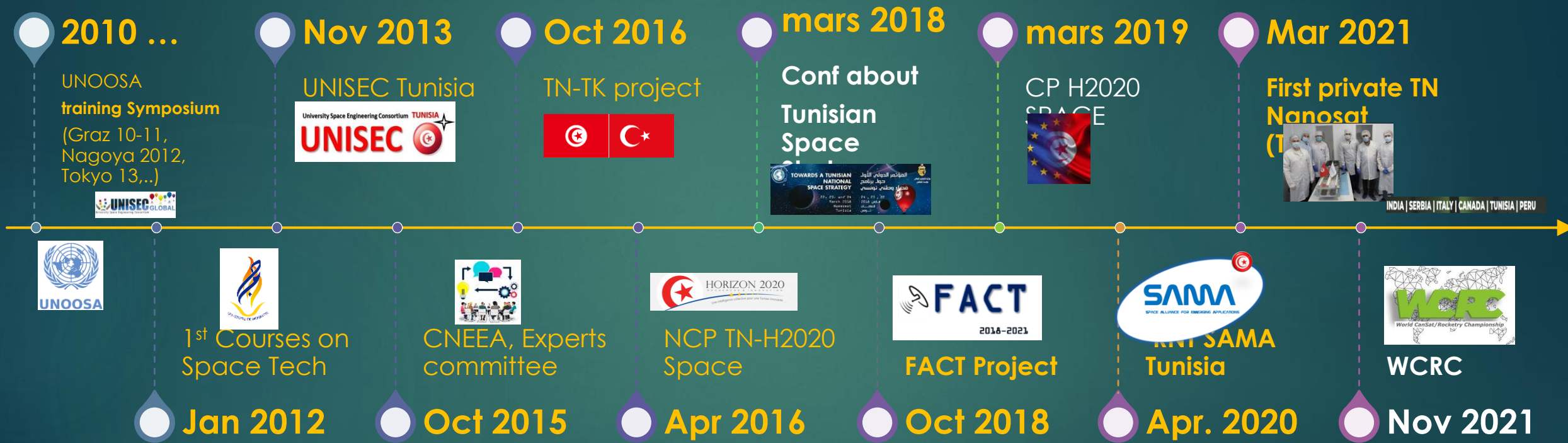


Fig. 1. Schematic of the channel designed



# Timeline : Moving to a Mobilizing Strategy



Governance, Networking, Events, Exhibitions, Conferences, Studies, Training, Research, Startups, Legislation, Major Projects, International Cooperation, Resources, ....

